Climate change beliefs and savings behavior: a macroeconomic perspective

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Motivation: anticipation of climate change impacts

Climate change is a major challenge of our time.

- Estimated GDP loss of 1°C of warming: 1.2% (Burke et al., 2015), 12% (Bilal and Känzig, 2024)
- 54% in UK state 'one of the most important issues facing the country' (average 2022-25)

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What are the macroeconomic implications of climate change beliefs?

- Do beliefs over climate change affect individual savings?
- Does the effect on capital accumulation lead to with macroeconomic consequences?
- Does disagreement over climate impacts matter for aggregate or distributional outcomes?

This paper: micro to macro

Micro behavior: Do climate beliefs affect individual savings?

Macro effects: Do climate beliefs matter for aggregate and distributional outcomes?

This paper: micro to macro

Micro behavior: Do climate beliefs affect individual savings?

- Partial equilibrium consumption-savings model
  - Analytical expression for savings response to change in climate change beliefs
- Empirical evidence from UK
  - Observational: representative UK panel survey
  - Causal: specific purpose online questionnaire

Macro effects: Do climate beliefs matter for aggregate and distributional outcomes?

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Macro effects: Do climate beliefs matter for aggregate and distributional outcomes?

- Non-stationary general equilibrium model with incomplete markets and aggregate risk
  - Climate change as shift in stochastic productivity process
  - Uncertainty over trend in productivity
  - Heterogeneity in income, wealth and beliefs

Key take-aways: The effects of climate change beliefs

Micro: Climate beliefs increase individual savings...

Macro: ...and affect transitional macroeconomic outcomes under more frequent climate damages.

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Micro: Climate beliefs increase individual savings...

- Theory
  - ➢ Higher concern over productivity impacts increases savings
  - ➢ Non-monotone dependence on idiosyncratic state
- Empirical evidence
  - ➢ Significant positive relationship between climate change beliefs and savings choices: Likelihood to save +9pp, savings share +1pp
  - ➢ Not fully attributable to preferences or exposure

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Macro: ...and affect transitional macroeconomic outcomes under more frequent climate damages.

- ➢ Climate concern effect: capital $\uparrow$, output loss from climate change $\downarrow$
  NPV of output: -12% under optimistic relative to accurate initial beliefs
- ➢ Benefits the poor disproportionally: wealth inequality temporarily $\downarrow$
- ➢ Small but persistent negative impacts of mean preserving spread in initial beliefs

Literature and contributions

Climate change impacts on the macroeconomy

- Stochastic damages: Golosov et al. (2014), Cai and Lontzek (2019)
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Contribution: Amplified consequences of climate uncertainty in decentralized framework

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Beliefs and disagreement over aggregate (climate) process

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Contribution: Implications along the transition

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Contribution: Implications along the transition

Incomplete markets and aggregate risks: theory and computation

- Krusell and Smith (1998), Farhi et al. (2022), Broer et al. (2022), Fernández-Villaverde et al. (2023), Bilal (2023), Auclert et al. (2021), Moll (2024),

Contribution: Non-stationarity in aggregate process, global solution method

Predictions in partial equilibrium

Savings response to a change in climate change beliefs

Choose consumption to maximize expected life-time utility, subject to budget constraint.

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Two types of uncertainty affect income:

- Aggregate state: productivity
  - ➢ Pins down average wages and asset returns
  - ➢ Two possible states: low and high $\{\zeta^L, \zeta^H\}$
  - ➢ Possibly dependent on climate change
- Idiosyncratic state: demographics, asset holdings
  - ➢ Affects labor and capital income
  - ➢ Independent of climate change

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How do savings depend on beliefs over climate change?

- ➤ How do consumption choices respond to changes in perceived probabilities of aggregate states?
- ➤ First order response to changes in beliefs from Euler equation (cf. Farhi et al., 2022)

First order consumption response

An increase in $p_1 = \mathbb{P}(\text{low productivity in } t = 1)$ affects consumption choice in period 0:

$$\frac{dc_0}{c_0} = -\varepsilon(c_0) \cdot MPS_0 \cdot \mathcal{D}_0 \; dp_1 \geq 0 \quad \text{for } dp_1 > 0.$$

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  $\rightarrow$ Small if borrowing constrained
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Responses to perturbations in future probabilities $dp_t, \; t > 1$

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Take-aways:

1. Concern over adverse macro risks increases individual savings
2. Opposing forces of current idiosyncratic state: large effect for poor savers

Empirical evidence

Empirical support for theoretical predictions

Model predictions:

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Two types of UK survey evidence:

1. Observational: large, representative UK panel survey
2. Causal: specific purpose online questionnaire

Observational data

UK Longitudinal Household Survey, waves 4 and 10 (2012-13, 2018-19)

- Construct index about climate change concern
- Savings variables (binary and amount)
- Demographic indicators
  - education, income, residence (LSOA), age, children

Exposure

- Flood data matched on residence

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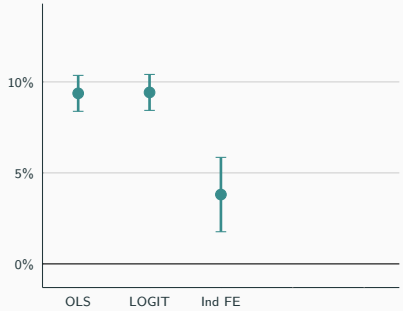
Addresses two main concerns:

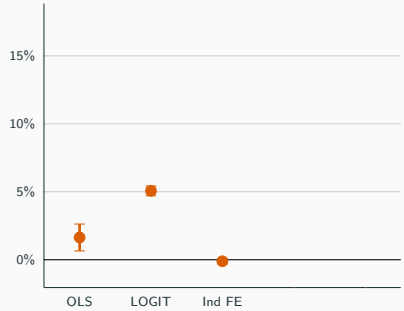
1. Preferences over risk and time $\rightarrow$ Individual fixed effects
2. Idiosyncratic exposure $\rightarrow$ Flood exposure, area fixed effects

Empirical results

Extensive margin
Average effect on likelihood to save



Intensive margin
Average effect in savings share



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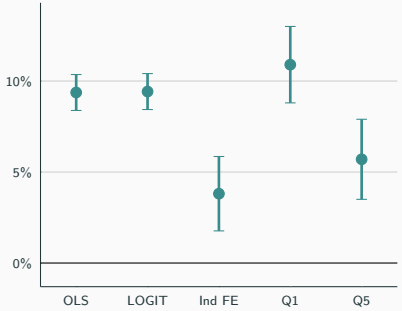

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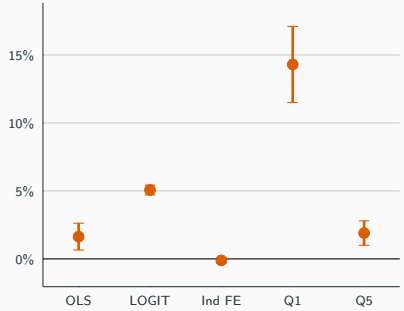

Specific purpose online survey

Goal: obtain causal evidence by using within-subject design (cf. Andre et al., 2025)

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- ➢ For each of 2 different climate impact scenarios: Increasing $\mathcal{I}$, Constant $\mathcal{C}$
- ➢ Presented in random order

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Questionnaire

- ➢ on overall concern, beliefs over specific mechanisms, personal savings behavior

Key statistic: relative effect of scenario on marginal savings $\Delta s = \dfrac{\text{Saved}\,|\mathcal{I} - \text{Saved}\,|\mathcal{C}}{\text{Saved}\,|\mathcal{C}}$

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	Full sample
Δs	7.6%***
Observations	543

	Income		
	low	medium	high
Δs	10.0%***	7.2%**	5.3%
Observations	178	230	81

Survey design | Sample | Questionnaire

Take-aways and open questions

Key take-aways:

- Passthrough of adverse aggregate risks: savings $\uparrow$, depending on idiosyncratic state
- Empirical evidence supporting positive relationship between climate concern and savings choices

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Open question: Do climate change beliefs matter for the macroeconomy?

- How does additional capital accumulation affect output losses during climate transition?
- Does the observed disagreement over climate change matter for macroeconomic outcomes?

$\rightarrow$ Dynamic general equilibrium model

General equilibrium model

General equilibrium model: endogenous prices

Households

- are subject to idiosyncratic shocks: income and life-cycle;
- consume and save to maximize EU, given budget constraint and borrowing limit.

Representative firm

- produces using capital and labor;
- pays wages and interest;
- is subject to productivity shocks $\zeta_t \in \{\zeta^L, \zeta^H\},\ \zeta^L < \zeta^H$.

Market clearing

- implies aggregate capital equals households' asset holdings.

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Climate change

- causes exogenous and deterministic increase in global temperature T_t;
- which is known at time $t = 0$ and may affect the frequency of low productivity states.

$\rightarrow$ Non-stationarity

Probability of adverse aggregate shock is given by $\mathbb{P}(\zeta_t = \zeta^L) = p^{1-\gamma T_t}$ with unknown parameter γ

- Two possible states of the world: $\gamma \in \{0, \overline{\gamma}\}$
- Individual initial belief $\pi_{it} = \mathbb{P}_0(\gamma = \overline{\gamma})$
- Bayesian updating

Climate change impacts

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Impacts modeled via measure, not sample space of aggregate process

- Any draw $\{\zeta_t\}_t$ possible under all beliefs
- Implicit level effect

Consumer problem

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Assumption: bounded rationality

Decisions are based on Perceived Law of Motion (PLM)

$$K' = \mathcal{H}(K; \mathcal{X}) \quad \text{for some explanatory variables } \mathcal{X}.$$

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How to choose PLM?

1. Find self-justified equilibrium to approximate rational expectations (Krusell and Smith, 1998)
   - Estimate $\mathcal{H}$ on simulated data, iterate until convergence
   - In stationary setting: log-linear $\mathcal{H}$, $\mathcal{X} = \zeta$ performs well

   $\rightarrow$ extend idea to non-stationary framework
2. Alternative to address Moll (2024) critique: adaptive expectations with varying degree of memory

PLM estimation

Fix some functional form

- ➢ Obvious candidates for $\mathcal{X}$: shock ζ, temperature T, personal belief π
- ➢ Guess for $\mathcal{H}$
  - linear in $\pi \rightarrow$ estimate only for $\pi \in \{0, 1\}$

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Generate simulated data

- ➢ Non-stationarity: ensemble of shock sequences
  - Stratified sample: Match theoretical mean and variance within each period

Iterate on parameters until convergence.

Stratification procedure | Model selection | Adaptive expectations with memory | Model performance | Heterogeneity in forecasts

Equilibrium and comparative statics

For period t: Ψ_t distribution of agents over demographics, asset holdings and beliefs.

Dynamic equilibrium

For a given draw $\{\zeta_t\}_t$, initial distribution Ψ_0 and PLM $\mathcal{H}$, the *dynamic equilibrium* of the economy is given by a sequence of distributions $\{\Psi_t\}_{t\geq 0}$ so that:

1. Each period, households and firms optimize given their beliefs; markets clear.
2. Ψ_t evolves according to (i) demographic dynamics, (ii) savings choices, and (iii) Bayes' formula.

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Summary statistics

- Stochastic steady state
- Ensemble averages

Calibration

Earnings and life-cycle:

- AR(1) process for skills estimated on UK panel data
- Expected duration working life (retirement): 40 (20) years; replacement rate 60%

Aggregate shocks: Effect of climate change on UK productivity

- AR(1) process for temperature, long-run increase of 0.9 deg within 75 years.
- Meta study Rising et al. (2022) estimates output losses:

$$1.1\% \text{ in } 2022,\ 3.3\% \text{ by } 2050,\ 7.4\% \text{ by } 2100$$

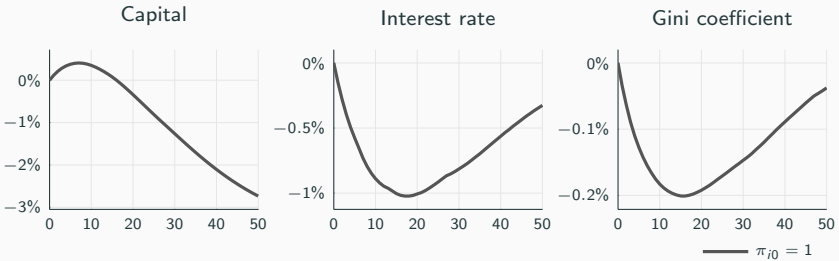
- Bad states $p_0 = 0.15$, $\zeta^L = 0.93$:

$$\mathbb{E}(\zeta_0) = 0.9895,\ \mathbb{E}(\zeta_{100}) = 0.965$$

The macroeconomic effects of climate beliefs

Baseline: $\overline{\gamma} = \gamma$

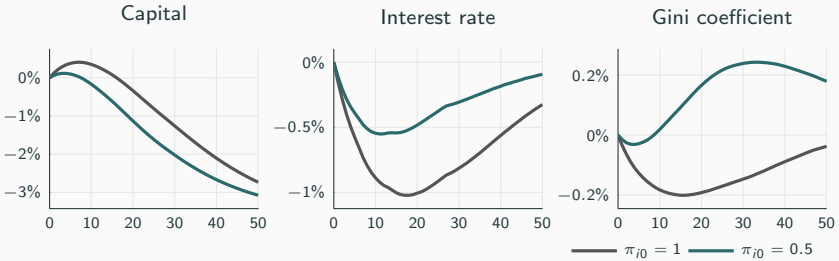
How does the climate affect the macroeconomy if everyone expects productivity impacts?



Ensemble averages over time, relative to initial SSS

The role of beliefs during the climate transition

Capital ↓ if agents believe 50% chance of no productivity impacts
→ wealth inequality rises



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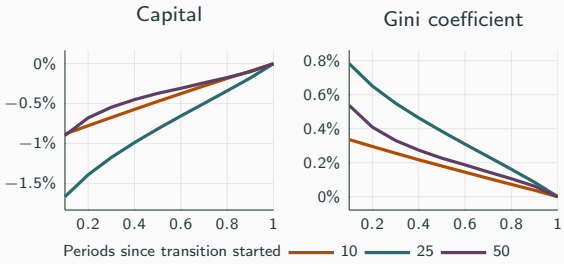
Learning: no long run divergence



Relative deviation to $\pi_{i0} = 1$ for $\pi_{i0} \in (0.1, 1]$

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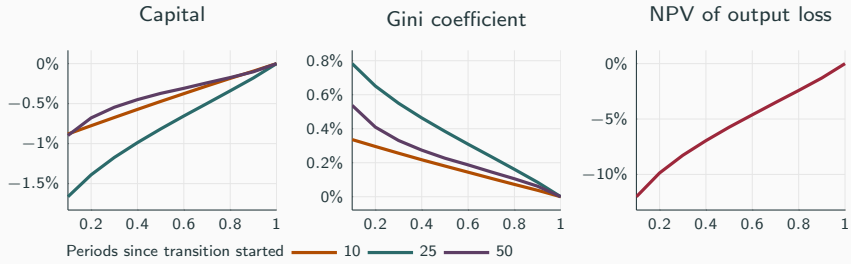

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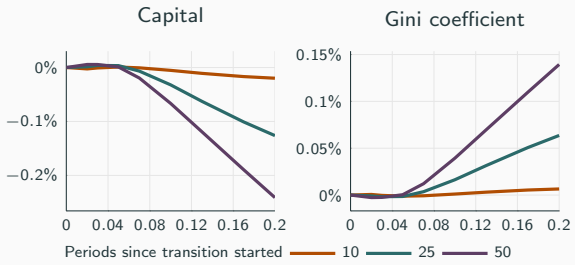
Belief dispersion

Mean preserving spread: Capital ↓, Gini ↑

More persistent: devation rises even after 25 years.



Relative deviation to $\text{Var}(\pi_{i0}) = 0$ for $\text{Var}(\pi_{i0}) \in [0, 0.2]$ at $\mathbb{E}(\pi_{i0}) = 0.7$.

But effect on output loss very small

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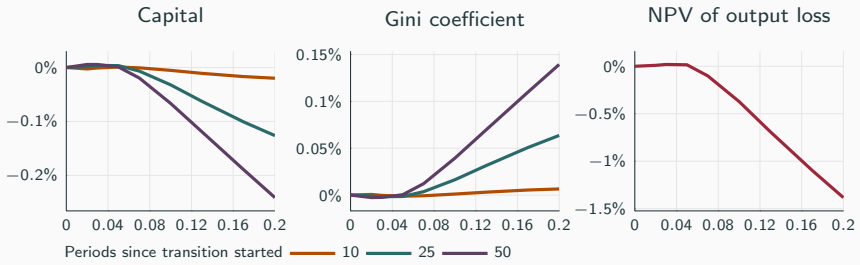

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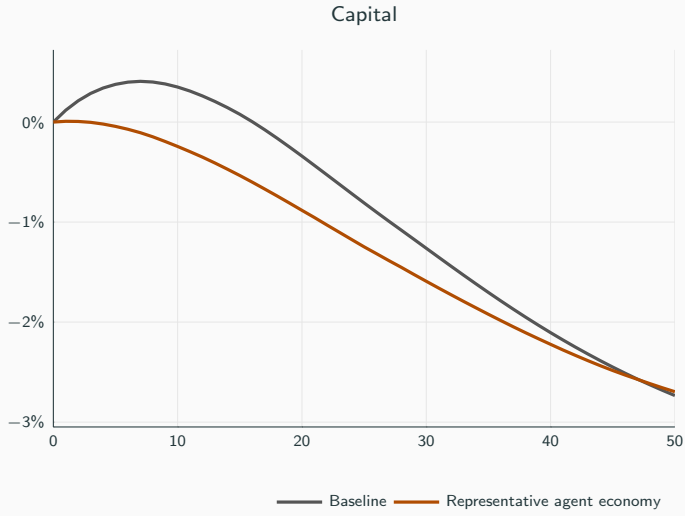
Mechanisms: The role of incomplete markets



Relative deviation to initial SSS

Conclusion: Beliefs over climate change matter for the macroeconomy.

Micro behavior

- Climate concern increases individual savings in model of aggregate climate damages
- Consistent with UK survey evidence

Macro effects

- Climate concern effect: capital increases in short-run, attenuates climate damages
- Heterogeneous impacts: decreasing wealth inequality
- Disagreement plays small but persistent role

Beliefs over aggregate risks in incomplete markets

- Development and solution of non-stationary model
- Applicable to range of questions on uncertainty and disagreement over structural shifts

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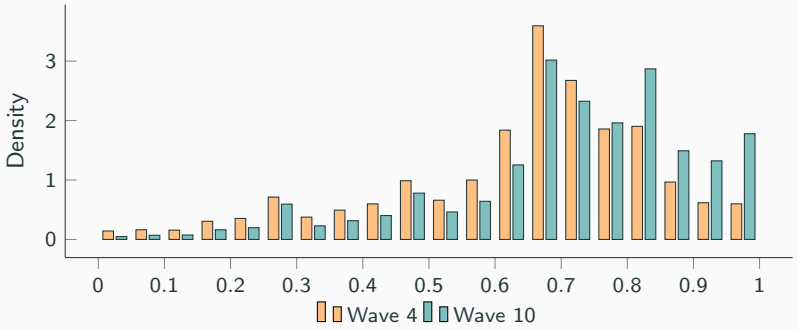

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